HEAT INSULATING WALL, AND METHOD OF MANUFACTURING THE SAME

FIELD OF THE INVENTION

Sub B1) The present invention relates to a wall including a vacuum insulation panel (member) to be used in a heat insulating transportation container of a vehicle enabling cold reservation and refrigeration.

DESCRIPTION OF ~~THE~~ RELATED ~~ART~~

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Sub B2) (1) As shown in FIG. 14, a heat insulating wall 13 of a body 15 in a refrigeration vehicle or cold reservation vehicle 10 applies the structures disclosed in the following:

Sub B3) a. a sandwich panel 13A formed by adhering a slab 131 made of expanded urethane foam or expanded styrene foam and the like (already expanded and formed into a plate-shape) to inner and outer panels 13a, 13b made of a plate-shaped flattened aluminum material, FRP, or steel, by use of an adhesive 13c; or

Sub B4) b. a panel 13B shown in FIG. 15, where an independent expanding urethane resin is injected and expanded between inner and outer panels 13a, 13b to form a portion 133, and bonding the inner and outer panels with the self-adhering force of urethane.

Normally, the heat insulating walls 13 of the body 15 are assembled into a box-shape, with the six walls, the ceiling, the floor, the two side walls, the front wall and the rear door,

being formed with the above mentioned panels (13A or 13B) having either the structure mentioned in a. or in b.

SubB5 (2) One demand for the heat-insulating container of vehicles is to increase the capacity within the container (body).

In order to increase the capacity of the container easily, the width and the height of the container should be enlarged. However, the outer frame size of the container is limited by regulations.

Therefore, in order to increase the inner size of the container without increasing the outer frame size of the container, there is a need to decrease the thickness of the wall (insulating member).

Of course, in order to decrease the thickness of the wall without deteriorating the insulation performance, it is indispensable to improve the insulating characteristics of the wall.

SubB6 One way to improve the heat insulation performance of the wall is to apply a vacuum insulation panel to the wall having a lower heat transfer rate than the conventionally used expanded plastic foam material.

SubB7 The heat conductivity of the heat insulating materials is shown in Table 1.

[Table 1]

Sample Materials	Heat conductivity [kcal/m·h·℃]
Polyurethane foam	0.020 – 0.022
Polystyrene foam	0.024 – 0.034
Vacuum insulation panel (filled with continuous expanded urethane foam, degree of vacuum: 10^{-2} Torr)	approximately 0.007
Continuous expanded urethane foam unit (without aluminum laminated film, atmospheric pressure)	approximately 0.045

Based on the heat transfer rate values shown in the above table, when calculating the necessary thickness of the heat insulating material when replacing the conventional polystyrene foam with a vacuum insulation material, the same heat insulating performance is obtained with the thickness of the wall reduced to approximately 1/4.

As explained, by utilizing a vacuum insulation member, the thickness of the insulating wall may be reduced without deteriorating the insulating performance. Therefore, by applying the wall, the capacity within the container may be increased, and the weight of the container may be reduced.

Sub B8 Even further, when the vacuum insulation material is employed to the wall without changing the thickness of the wall, the heat insulating performance may be quadrupled, and the fuel consumption rate will be improved.

Sub B9 (3) From the above reasons, the wall including the vacuum insulation material is already applied to portions of domestic (home) refrigerators. The wall structure applied to a domestic

Cont. B9 refrigerator utilizing the vacuum insulation panels is explained with reference to FIG. 16.

Sub B11 In a domestic refrigerator 20, vacuum insulation panels 25 are incorporated to the outer walls 24 of a cooling chamber 21, a refrigerating chamber 22 and a vegetable chamber 23, the interior temperature of which must be maintained to 4-5 ℃ or to -18 ℃.

The vacuum insulation panel 25 is formed by placing a continuous expanded urethane foam 25a inside a bag 25b made of aluminum laminated film, and under vacuum condition, the bag is airtightly sealed by a seal portion 25c. The outer panel 24 of the refrigerator is formed by placing the vacuum insulation panel 25 between a flat steel outer plate 24a and a molded inner plate 24b made of three-dimensionally deformed ABS resin and the like formed by vacuum molding. The vacuum insulation panel 25 is fixed to the outer panel 24a by a hot-melt adhesive or a double-coated tape. An independent expanding urethane foam 24c is injected and expanded in the space formed between the vacuum insulation panel 25, the inner panel 24b and the outer panel 24a.

Sub B11 In the wall structure, the bond between the outer panel 24a, the inner panel 24b, the aluminum laminated film 25b and the independent expanding urethane foam 24c is stronger than the self-adhering power of the urethane foam.

9/23/04 Sub B12 Therefore, in a domestic refrigerator, there is no need to bond the materials by use of fastening members such as rivets.

These types of vacuum insulation panels are disclosed for example in Japanese Patent Publication Nos. 61-17263, 1-46759, and 3-23825.

SUMMARY OF THE INVENTION

Sub B13 The present invention aims at solving the problems related to using a vacuum insulation panel for a heat insulating travel container, which differs from the domestic refrigerator in the environment of use and the manufacturing method.

[The difference in the environment of use and the manufacturing method between a domestic refrigerator and a heat insulating travel container]

Sub B14 1) During transportation of the heat insulating travel container, the container is vibrated and deformed when traveling on a rough path or riding over a curbstone and the like, and this causes the wall to receive bending or torsional load. The wall structure of a domestic refrigerator as explained adheres the vacuum insulation panel to the outer panel. When such load is added to the wall, the stress will be directly transmitted to the vacuum insulation panel, and the intensity of the film may not bare such stress. As a result, the film may be torn. When the film is torn, the panel can no further maintain a vacuumed condition, and the heat insulating performance of the vacuum insulation panel is deteriorated.

Sub B15 Accordingly, when the vacuum insulation panel is utilized as the component of a wall for a heat insulating travel container,

Cont. B15 the vacuum insulation panel should be positioned near the center of thickness of the wall, so that when bending or torsional load is added to the wall, only a small stress is transmitted to the film of the vacuum insulation panel.

Sub B16 2) Generally, a forklift is utilized for loading the luggage in and out of the refrigerating travel container. At this time, there is fear that the claws of the forklift may bump into the insulating wall, or obstacles outside the container may hit the wall, causing damage to the outer panel.

Sub B17 If the vacuum insulation panel is positioned close to the outer or inner panels of the insulating wall, the damage added to the panels may cause the film to break, and the insulating performance of the vacuum insulation panel may be deteriorated.

Accordingly, when the vacuum insulation panel is used as a component forming the wall utilized in the heat insulating travel container, the vacuum insulation panel must be positioned in the center of thickness of the wall.

3) Moreover, various parts, rails and angles are fixed to the inner and outer panels of the container by fastening members (rivets). A pull-stem type rivet is normally used for the heat insulating container. Other rivets include a solid-type, a full-tubular type, a semi-tubular type, a split-type, a compression-type, a blind rivet and the like.

With reference to FIGS. 17 and 18, the method of fixing a pull-stem type rivet is explained.

A rib 16, a doorframe 17 and the like are mounted to the

inner panel 130a and the outer panel 130b of the heat insulating travel container 15.

The method of fixing the rib 16 is explained.

Sub B1 A base hole 130c is formed to the inner panel 130a (or the outer panel 130b) with a drill. Thereafter, a rivet 18 is inserted to the hole, and the rivet is pulled and fixed by a riveter. This may cause no trouble to the sandwich panel, but if the vacuum insulation panel 25 is placed between the inner and outer panels 130a, 130b, the film 25b of the panel 25 may be damaged when drilling the base hole or when inserting the rivet to the hole.

Normally, a stopper is provided to the drill so as not to drill too deep, but the position of the stopper differs according to each manufacturer, and the depth of the base hole is not regular. For example, in this type of walls, the drill is provided with a stopper that stops the drill at a depth of 15 mm. In other words, the rivets could not be fixed to a base hole shorter than approximately 15 mm. Therefore, the vacuum insulation material should be placed in the center of thickness of the wall, with distances of 15 mm $+\alpha$ away from the inner and outer panels, respectively. The clearance size α should be set to approximately 10 mm, for safety when forming a base hole.

Other than the above members, parts that may be fixed to the heat insulating wall include the following: (The problems that are related to mounting these parts are the same as those

for the rivet.)

a lashing rail (fixed to the inner panel) for fixing a lashing belt which prevents the luggage inside the container from moving by the vibration, the starting or the stopping of the vehicle;

a pallet guide (fixed to the inner panel) preventing the luggage inside the container from bumping into the side walls by the vibration, the starting or the stopping of the vehicle;

an air rib (fixed to the inner panel) for accelerating the dispersion of cool air within the container; and

an angle fixed to the interior and a rail fixed to the exterior of the corner portion, joining the walls together.

(5) The conventional methods for determining the necessary distance between the vacuum insulation panel and the inner and outer panels, and the method of fixing the panel to position include the following:

1) Japanese Laid-Open Utility Model Application No. 4-68989 discloses placing a single-body vacuum insulation panel inside a flat panel-shaped mold, and injecting a urethane foam material around the insulation panel, so as to manufacture a vacuum insulation panel unit with an urethane cover. The unit is placed between the inner and outer panels. In this case, the vacuum insulation panel placed within the mold for injection tended to move around the mold by the expanding pressure of the urethane material, and it was very difficult to fix the vacuum panel to a determined position at the center of thickness of the wall material.

2) Japanese Patent Publication No. 2-9272 discloses a method of spraying a urethane foam to the inner panel or the outer panel, and while the urethane foam is gelling or expanding, adhering a vacuum insulation panel to the urethane material.

According to the disclosed technique, there is a large dispersion to the state of expansion of the sprayed foam, and it was difficult to fix the vacuum panel to a determined position away from the inner panel or the outer panel.

3) Japanese Utility-Model Publication Nos. 1-20631 and 3-38628 disclose a wall formed by adhering a deforming sponge or plastic resin to the inner and outer panels, and mounting a vacuum insulation panel on that layer. An urethane foam material is injected around the vacuum panel, so as to cover the outside of the panel. However, since the deforming sponge or deforming plastic resin are deformed by the expanding pressure of the urethane foam, it was difficult for the vacuum panel to be fixed to a determined position away from the inner and outer panels.

4) Japanese Laid-Open Patent Application Nos. 3-233285, 8-14484 and 8-14486 disclose fixing a vacuum insulation panel to a desired position in the width of the wall by a fixing jig. However, since the fixing jig itself has a very high heat conductivity, a heat-bridge is generated within the wall, and it was difficult for the wall to provide a sufficient heat insulating performance.

Therefore, in order to solve the above-mentioned problems,

the present invention provides a wall structure for a heat insulating container of a vehicle, adopting a wall structure including a vacuum insulation panel mounted to a predetermined position away from the inner and outer panels, for example at the center of width of the wall. The wall structure of a container according to the invention is advantageous in that the vacuum insulation panel maintains a high heat insulating performance.

The heat insulating wall including vacuum insulation members according to the present invention comprises a first panel, a first heat insulating material mounted on said first panel, one or more vacuum insulation members arranged on said first heat insulating material, a second heat insulating material mounted on said vacuum insulation member, a second panel mounted on said second heat insulating member, and a filler insulating member for filling areas surrounded by said first heat insulating material, said vacuum insulation member and said second heat insulating material, wherein the thickness of said first and second heat insulating materials are set to a predetermined size.

The heat insulating wall according to another aspect of the invention comprises a first panel; first pillar-shaped heat insulating materials made of hard plastic foam arranged on the first panel with predetermined intervals between one another, the width of the first insulating materials being set to approximately the same width as the vacuum insulation members, and the thickness thereof being set to a predetermined size;

vacuum insulation members each arranged on the first pillar-shaped heat insulating materials; second pillar-shaped heat insulating materials made of hard plastic foam to a shape similar to that of the first insulating materials and mounted on the vacuum insulation members; and a second panel mounted on the second pillar-shaped heat insulating members; and an expanding plastic foam for filling areas surrounded by the first pillar-shaped heat insulating materials, the vacuum insulation members and the second pillar-shaped heat insulating materials between the first panel and the second panel.

The heat insulating wall according to other aspects of the invention include structures where the vacuum insulation members are adhered to said heat insulating materials by a soft adhesive, where the plate-shaped heat insulating members or said pillar-shaped heat insulating members are formed of hard plastic foams, or where the vacuum insulation member sandwiched between the first and second pillar-shaped heat insulating materials constitute a unit body.

The heat insulating wall according to another aspect of the invention comprises a first panel, a first plate-shaped heat insulating material formed of a non-expanding plastic foam formed to have a predetermined thickness and mounted on the first panel, vacuum insulation members arranged on the first plate-shaped heat insulating material, a second plate-shaped heat insulating material made of a non-expanding plastic foam formed to have a predetermined thickness and mounted on the

vacuum insulation members, a second panel mounted on the second plate-shaped heat insulating member, and non-expanding plastic foam materials mounted to areas surrounded by the first heat insulating material, the vacuum insulation members and the second heat insulating material between the first panel and the second panel, wherein seal portions of the vacuum insulation members are supported by the filling insulation materials.

The heat insulating wall according to another aspect of the invention comprises a first panel with a first plate-shaped insulating material made of an insulating material fixed thereto, a second panel with a second plate-shaped insulating material made of an insulating material fixed thereto, and vacuum insulation member units mounted between the first plate-shaped insulating material and the second plate-shaped insulating material, wherein the units each comprise a vacuum insulation member and seal support portions for supporting the seal portions of the vacuum insulation member.

The thickness of the first and second plate-shaped heat insulating materials is set to a predetermined size. Further, the first and second plate-shaped heat insulating materials and the seal supporting portions are made of non-expanding plastic foam.

Moreover, the seal support means of the seal support portion of the vacuum insulation member unit includes a first seal support portion and a second seal support portion. In another example, the seal support means of the seal support portion of the vacuum

insulation member unit is a concave portion.

The insulating wall according to another aspect of the invention comprises a first panel, a second panel, and vacuum insulation member units fit and stored in first and second storage portions formed between the first and second plates, wherein the distance between the first panel and the bottom of the fitting portion of the first storage portion, and the distance between the second panel and the bottom of the fitting portion of the second storage portion are both set to a predetermined size (equal to a depth of a base hole for inserting a fastening member plus an appropriate clearance).

The method of manufacturing a heat insulating wall according to another aspect of the invention comprises a first plate-shaped heat insulating material positioning step of adhering and fixing a first plate-shaped heat insulating material onto a first panel, a second plate-shaped heat insulating material positioning step of adhering and fixing a second plate-shaped heat insulating material onto a second panel, a vacuum insulation member positioning step of sandwiching the vacuum insulation members with the first and second plate-shaped heat insulating materials, and an expanding plastic filling step of injecting liquid-plastic into a gap between the first and second plate-shaped heat insulating materials and letting the plastic to foam, wherein the vacuum insulation members are arranged with appropriate intervals therebetween so that proximal vacuum insulation members do not come into contact with each other,

and the first and second plate-shaped heat insulating materials have a predetermined thickness.

The method of manufacturing a heat insulating wall according to another aspect of the invention comprises a first pillar-shaped heat insulating material positioning step of adhering and fixing first pillar-shaped heat insulating materials onto a first panel, a vacuum insulation member positioning step of mounting the vacuum insulation members to the first pillar-shaped heat insulating materials, a second pillar-shaped heat insulating material positioning step of adhering and fixing second pillar-shaped heat insulating materials onto the vacuum insulation members, a second panel positioning step of mounting a second panel onto the second pillar-shaped heat insulating materials, and an expanding plastic filling step of injecting liquid-plastic into a gap between the first and second panels and letting the plastic to foam, wherein the first pillar-shaped heat insulating materials to which the vacuum insulation members are mounted are arranged with appropriate intervals therebetween so that proximal vacuum insulation members do not come into contact with each other, and the first and second pillar-shaped heat insulating materials have a width size which is roughly the same size as the width of the vacuum insulation member.

The method according to another aspect of the invention comprises a unit forming step of forming a unit by sandwiching a vacuum insulation member with first and second pillar-shaped

heat insulating materials, wherein the units are arranged between a first panel and a second panel, and liquid plastic is injected and expanded in a gap between the first panel and the second panels.

The method according to another aspect of the invention comprises a first plate-shaped heat insulating material positioning step of adhering and fixing a plate-shaped heat insulating material made of non-expanding plastic foam onto a first panel; a vacuum insulation member positioning step of arranging, on the first plate-shaped heat insulating member, filling heat insulation members made of non-expanding plastic foam including first and second members for sandwiching and supporting the seal portions of adjacent vacuum members; and a pressurization step of positioning, on the vacuum insulation members, a second panel to which are adhered and fixed a plate-shaped heat insulating material made of non-expanding plastic foam; wherein the thickness of the plate-shaped heat insulating materials adhered to the first and second panels are set to a predetermined size.

The method according to another aspect of the invention comprises a first plate-shaped heat insulating material positioning step of adhering and fixing a plate-shaped heat insulating material formed of non-expanding plastic foam and having a predetermined thickness onto a first panel, a second plate-shaped heat insulating material positioning step of adhering and fixing a plate-shaped heat insulating material

formed of non-expanding plastic foam and having a predetermined thickness onto a second panel, a unit forming step of assembling a vacuum insulation member unit comprising a vacuum insulation member and a seal support portion for supporting the seal portion of the vacuum insulation member, and a pressurizing step of sandwiching the vacuum insulation member units with the first and second panels to which are fixed plate-shaped insulating materials, and adhering the units to position.

According to other aspects of the method, the seal support portion for supporting the seal portions of said vacuum insulation member may include a first support portion and a second support portion, which support the seal portions to form the vacuum insulation member unit, or a concave portion capable of supporting the seal portion, and the vacuum insulation member unit may be formed by inserting said seal portion to the concave portion of said support portion.

The method according to another aspect of the invention comprises a unit forming step of storing a vacuum insulation member within an insulation storage portion, formed of first and second storage portions each having a fitting portion, so as to form a unit; and a pressurizing step of sandwiching the vacuum insulation member units with a first panel and a second panel, and fixing the unit to position.

The above method characterizes in that both the distance between the first panel and the bottom of the fitting portion of the first storage portion and the distance between the second

panel and the bottom of the fitting portion of the second storage portion are set to a predetermined size (equal to a depth of a base hole for inserting a fastening member plus an appropriate clearance).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of the heat insulating wall according to the present invention;

FIG. 2 is an explanatory view showing the structure of the insulating wall according to the present invention;

FIG. 3 is a cross-sectional view showing another embodiment of the insulating wall according to the invention;

FIG. 4 is an explanatory view of the structure of FIG. 3;

FIG. 5 is an explanatory view showing another embodiment of the invention;

FIG. 6 is a cross-sectional view showing the wall according to embodiment 4 of the invention;

FIG. 7 is an explanatory view showing the structure of FIG. 6;

FIG. 8 is a cross-sectional view showing the wall according to embodiment 5 of the invention;

FIG. 9 is an explanatory view of FIG. 8;

FIG. 10 is an explanatory view of yet another embodiment;

FIG. 11 is an explanatory view of the vacuum insulation member unit;

FIG. 12 is a cross-sectional view of the heat insulating

wall according to embodiment 6 of the invention;

FIG. 13 is an explanatory view of FIG. 12;

FIG. 14 is an explanatory view of a prior art heat insulating wall structure of a vehicle;

FIG. 15 is an explanatory view of another prior art heat insulating wall structure of a vehicle;

FIG. 16 is an explanatory view showing the wall structure of a domestic refrigerator;

FIG. 17 is a perspective view of a vehicle; and

FIG. 18 is an explanatory view showing the fixed rivet according to the prior art.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The preferred embodiment according the present invention will now be explained with reference to the accompanied drawings.

(Embodiment 1)

FIG. 1 shows a cross-sectional view of a wall according to the first embodiment of the present invention.

A wall 50 comprises a first panel 51A and a second panel 51B acting as an outer panel and an inner panel, a slab material 53 made of a heat insulating material, and a vacuum insulation member 60.

A plate-shaped slab material 53 having a heat insulating effect is adhered to the first panel 51A and the second panel 51B. The plate-shaped slab material 53 is made of hard-type plastic foam such as styrene foam or urethane foam. The

thickness S of the material 53 is equal to or above the size of a base hole plus α. For example, if the size of the base hole is 15 mm and the clearance (α) is 10 mm, the size S is equal to or above 25 mm.

An adhesive 52 for the first and second plates 51A, B and the slab material 53 may be thermoplastic adhesive (vinyl acetate system, acrylic system, polyamide system, polyester system, polyurethane system, etc.,) hot-setting adhesive (amino system, urea system, melamine system, phenol system, resorcylic system, xylene system, furan system, epoxy system, urethane system, acryl system, unsaturated polyester system, etc.,) hot-melting adhesive (including reaction setting adhesive,) rubber-system adhesive, cyanoacrylate adhesive, synthetic water-soluble adhesive, emulsion adhesive, liquid polymer adhesive, and so on.

Especially, when taking into consideration the heat increase (approximately 80-90 ℃) caused by the insolation outside, adhesives having heat resisting property, such as the hot-setting urethane adhesive, the epoxy adhesive or the reaction-setting hot-melting adhesive are preferred.

Further, of the above-listed adhesives, the adhesives including a solvent tend to dissolve the plastic foam by the solvent included, or the solvent may diffuse after adhesion and cause exfoliation of the adhesive. Therefore, the adhesives having no solvents included are preferred.

The vacuum insulation member 60 is positioned between the

slab member 53 of the first panel 51A and the slab member 53 of the second panel 51B.

The slab material 53 and the vacuum insulation member 60 are adhered by an adhesive 62. In this case, the adhesive may be thermoplastic adhesive (vinyl acetate system, acrylic system, polyamide system, polyester system, polyurethane system, etc.,) hot-setting adhesive (amino system, urea system, melamine system, phenol system, resorcylic system, xylene system, furan system, epoxy system, urethane system, acryl system, unsaturated polyester system, etc.,) hot-melting adhesive (including reaction setting adhesive,) rubber-system cyanoacrylate adhesive, synthetic water-soluble adhesive, emulsion adhesive, liquid polymer adhesive, and so on.

The vacuum insulation member 60 is formed by coating an aluminum-laminated film 61 to continuous expanded foam 65 made of synthetic resin, and sealing the same at a seal portion 67 so as to provide a vacuumed state.

The aluminum-laminated film 61 is a laminated body made of a nylon layer, a polyester resin layer to which is evaporated aluminum (AL), an AL leaf layer, and a polyethylene layer. The total layer thickness is 83 μm.

The filling to the aluminum-laminated film 61 may be continuous expanded urethane foam of the organic system and other continuous expanded foams made of resin (polystyrene, polyethylene, polypropylene, phenol, urea, ABS, vinyl chloride, nylon, ethylene-vinyl acetate, rubber, etc.,) and form pearlite

of the inorganic system, silica balloon, glass micro balloon, silica, hydrate silicate, calcium silicate, diatomaceous earth, methylation silicate, magnesium carbonate, alumina silicate, carbon foam, fiber wool (glass wool, asbestos, ceramic fiber, cotton wool, polyester wool, silica-alumina wool, etc.,) and the like.

The degree of vacuum inside the film 61 of the vacuum insulation member 60 is not especially defined, but preferably from the point of view of insulation effect and the time to reach the vacuum state, it may approximately be 10^{-2} Torr.

Moreover, a getter agent is placed to the interior of the vacuum insulation member 60. The getter agent is for adsorbing the gas that prevents the member from maintaining the degree of vacuum. The agent may be an adsorption type of activated carbon or zeolite, or may be chemical-reaction adsorption type.

The vacuum insulation member 60 is placed so that it maintains an appropriate interval with proximate vacuum insulation members 60, so as not to contact the other members 60.

The portion surrounded by the slab material 53 and the vacuum insulation member 60 is filled with an urethane foam 55 formed by injecting and expanding urethane resin. The urethane foam 55 is adhered to the upper and lower panels 51A, B, the slab material 53, and the vacuum insulation member 60 by self-adhesion.

The method of manufacturing the wall 50 is now explained

with reference to FIG. 2.

(1) The slab material 53 is adhered to panel 51A and panel 51B, respectively.

The plate-shaped slab material 53 made of plastic foam (styrene form, urethane foam and the like) with a plate thickness S of approximately 25 mm is adhered at its contact surface to the first and second panels 51A and 51B through the adhesive 52. Thereby, the first panel 51A to which the slab material 53 is adhered and the second panel 51B to which the slab material 53 is adhered is manufactured.

(2) Thereafter, the vacuum insulation members 60 are adhered to the slab material 53 fixed to the first panel 51A, with even intervals between the members 60, so that they do not come into contact with one another.

The adhesive 62 may either be applied to both surfaces of the vacuum insulation member 60, or may be applied to the whole surface of the slab material 53, before placing the vacuum insulation members 60 to the predetermined positions.

(3) The slab material 53 fixed to the second panel 51B is placed on top of the vacuum insulation member 60, and fixed thereto by pressurized adhesion.

Actually, the adhesive 62 is either applied on the upper surface of the vacuum insulation member 60 before performing the pressurized adhesion, or the adhesive 62 is applied to the whole surface of the slab material 53 fixed on the second panel 51B before placing it on the vacuum insulation panel 60 and

performing the pressurized adhesion.

Thereby, the vacuum insulation member 60 is sandwiched between the first plate 51A with the slab material and the second plate 51B with the slab material.

(4) After adhering the first and second panels 51 A, B with the slab material 53 to both sides of the vacuum insulation member 60, a urethane foam material-liquid is injected to the spaces surrounded by the vacuum insulation panel 60 and the slab material 53 made of plastic foam (insulating material).

The injected urethane foam material-liquid fills complicated spaces such as the area around the heat seal portion 67 of the member 60 and the small gap between the member 60 and the plastic foam slab material 53, and expands. Then, by self-adhesion or by use of an adhesive, it is adhered to the surrounding members.

The heat insulating wall 50 manufactured as above may position the vacuum insulation member 60 to be arranged approximately in the center of wall thickness and separated by a distance (25 mm) from the inner and outer panels (51A, 51B) having predetermined sizes, by setting the thickness S of the slab materials 53 on the first and second (inner and outer) panels to a predetermined size (for example, 25 mm). Further, since a urethane material-liquid is filled by injection to the spaces within the member, there will be no spaces having high heat conductivity formed in the wall. Therefore, the present method provides a wall structure member with good heat

insulating characters.

Moreover, since the vacuum insulation member 60 is placed approximately in the center area of wall thickness of the wall structure member 50, the loads to the wall such as the vibration when used for vehicles, the bend or torsion caused by deformation, or the outer damages to the wall caused by the claws of a forklift and the like, will not reach the film. Therefore, outer damage will not reach the vacuum insulation member 60 easily. Further, since the plate-thickness of the slab material 53 is greater than the base hole size, the riveting performed when manufacturing the insulating container will not damage the vacuum insulation member 60.

In the present embodiment, the adhesive 62 applied on both sides of the insulation member 60 should preferably be soft. That is, when using the completed container, and a load is added to the wall 50, the adhesive may deform or expand to correspond to the load, and only very limited stress reaches the aluminum-laminated film 61 of the member 60.

The soft adhesive may preferably be the RT-16 (trademark) manufactured by Japan NSC K. K.

As explained, the wall or the manufacturing method of the wall shown in the present embodiment is advantageous in that the vacuum insulation members 60 may be securely mounted to a position away from the inner and outer plates 51A, 51B by a predetermined distance (base hole size for riveting + α) so that they receive small outer influence. Moreover, the

insulating characters of the vacuum insulation members 60 positioned approximately at the center of thickness of the wall would not be damaged by vibration, torsion or outer forces. Therefore, a secure insulation is provided.

(Embodiment 2)

The present embodiment provides another wall structure capable of fixing the vacuum insulation member to a predetermined position, and the method of manufacturing the same (refer to FIGS. 3 and 4.)

The wall 80 shown in the present embodiment includes vacuum insulation members 60 sandwiched by slab materials 83 having roughly the same size as the vacuum insulation members.

The method of manufacturing the wall 80 will now be explained.

(1) A plurality of pillar-shaped first slab (insulating) materials 83A formed of hard plastic foam with a thickness S (for example, 25 mm) and a width W equal to the width W of the vacuum insulation member 60 are adhered to the first panel 81A acting as the outer panel.

The first slab materials 83A are positioned with appropriate intervals.

The adhesive 82 is either applied only to the adhesion surface of the first slab material 83A, or to the whole surface of the first panel 81A.

(2) The adhesive 85 is applied on the first slab materials 83A. Then, the vacuum insulation members 60 are placed and

adhered thereto.

(3) The adhesive 85 is applied on top of the vacuum insulation members 60, and pillar-shaped second slab (insulating) members 85B having the same size as the first slab material 83A are mounted for adhesion to the adhesive.

At this stage, the vacuum insulation members 60 sandwiched with the pillar-shaped first slab materials 83A and the pillar-shaped second slab materials 83B are fixed with even intervals.

(4) The adhesive is applied on top of the second slab materials 83B, and the second panel 81B is fixed thereto by pressurized adhesion. Or instead, the adhesive 82 may be applied to the whole surface of adhesion of the second panel 83B.

(5) After adhesion, an urethane foam material-liquid is injected to the spaces surrounded by the vacuum insulation members 60 sandwiched by the first slab materials 83A and the second slab materials 83B made of plastic foam and the first and second panels 81A, 81B. The urethane foam material-liquid is injected to and completely fills the area around the heat seal portion 67 of the vacuum insulation member 60 and the small gap of the adhered portion between the slab materials 83A, 83B and the members 60.

Then, the urethane foam material-liquid is expanded within the space, so as to complete the wall 80.

Similar to embodiment 1, the adhesive 85 applied to both

sides of the vacuum insulation members 60 should be soft, so that the adhesive may be deformed (expanded) to correspond to the load added to the wall 80, or to reduce the stress to the aluminum-laminated film of the member 60.

As explained, the wall 80 and the method of manufacturing the same according to the present embodiment is advantageous in that the vacuum insulation members 60 are securely mounted to a position away from the inner and outer plates 81A, 81B with a predetermined distance (base hole size for riveting + α) so that they receive small outer influence. Moreover, the vacuum insulation members 60 positioned approximately at the center of thickness of the wall would not be damaged of its insulating characters by vibration, torsion or outer force. Therefore, a secure insulation is provided.

(Embodiment 3)

The present embodiment includes sandwiching the vacuum insulation member with slab materials, and forming a unit.

The method of manufacturing the wall according to the present embodiment will now be explained with reference to FIG. 5.

(1) The vacuum insulation member 60 is sandwiched, via an adhesive, by pillar-shaped first and second slab materials 93A and 93B, both having the same width size as the width W of the vacuum insulation member 60 and a thickness S. Then, pressurized adhesion is performed thereto.

Thereby, a unit 90U formed by sandwiching the vacuum insulation unit 60 with hard plastic foam slab materials 93A

and 93B is completed.

(2) The adhesive is applied to both sides of the unit 90U. A first panel 91A is pressurized and adhered to the first slab material 93A, and a second panel 91B is pressurized and adhered to the second slab material 93B. The adhesive may be applied to the adhering side of the first and second panels 91A and 91B.

(3) After adhering the unit 90U and the first and second panels 91A and 91B, a urethane foam material-liquid is injected to the spaces surrounded by the unit 90U, the first panel 91A and the second panel 91B. The urethane foam is expanded within the spaces, thereby completing the wall 90.

According to the wall 90 including units 90U formed by sandwiching the vacuum insulation member 60 with slab materials 93A and 93B, it is easy to handle the vacuum insulation members 60.

(Embodiment 4)

FIG. 6 is a cross-sectional view of a heat insulating wall according to embodiment 4 of the present invention.

A heat insulating wall 500 according to the present embodiment comprises a plate-shaped first slab material 530A having an insulating effect and adhered to a first panel 510A, and a plate-shaped second slab material 530B having an insulating effect and adhered to a second panel 510B. The plate-shaped slab materials 530A and 530B are formed of non-expanding plastic foam such as styrene form or urethane foam and the like. The

thickness S of the slab materials are set to be equal to or larger than the size of a base hole formed thereto for inserting fastening members plus a clearance portion (α). For example, when the size of the base hole in the embodiment is 15 mm, and the clearance (α) is set to 10 mm, the thickness S is equal to or over 25 mm.

An adhesive 520 for adhering the first and second panels 510A, 510B and the slab material 530 is the same as that explained in embodiment 1.

Vacuum insulation members 60 are positioned between the first slab material 530 adhered and fixed to the first panel 510A and the second slab material 530B adhered and fixed to the second panel 510B, with appropriate intervals between each member 60 so that they do not come into contact with one another.

Filling slab materials 550 are placed in the spaces surrounded by the first slab material 530A, the second slab material 530B, and the vacuum insulation members 60.

The filling slab materials 550 are formed of a non-expanding plastic foam such as a styrene foam or an urethane foam and the like, similar to the first and second slab materials 530A, 530B. The filling slab materials 550 include a first filling slab material 550A and a second filling slab material 550B.

The height t of the first and second filling slab materials 550A and 550B are set to approximately half the height T of the vacuum insulation member 60 ($t = T/2$). When the first and second filling slab materials 550A and 550B are superposed,

their height equals the height of the vacuum insulation member 60.

A seal portion 67 of the vacuum insulation member 60 is sandwiched by the first filling slab material 550A and the second filling slab material 550B, which are adhered and fixed to position.

The method of manufacturing the wall 500 is explained now with reference to FIG. 7.

(1) Slab materials 530 are adhered to plate 510A and plate 510B, respectively.

The plate-shaped slab materials 530, made of non-expanding plastic foam (styrene foam, urethane foam, etc.) with a plate thickness S of approximately 25 mm, are adhered by an adhesive at its contact surface with the first and second panels 510A, 510B, respectively. Thereby, a first panel 510A to which the slab material 530A is adhered, and a second panel 510B to which the slab material 530B is adhered, are manufactured (refer to a.)

(2) On top of the first slab material 530A adhered to the first panel 510A are adhered the vacuum insulation members 60 and first filling slab materials 550A formed of non-expanding plastic foam. Since the height t of the first filling slab material 550A is approximately half the height T of the vacuum insulation member 60, the seal portion 67 of the vacuum insulation member 60 is placed on top of the first filling slab material 550A. In this state, the width W of the first filling slab

material 550A is set so that the seal portions 65 of the proximate vacuum insulation members 60 do not come into contact with each other (when the length of the seal portion 65 is x, W ≧ 2w) (refer to b).

(3) The second filling slab material 550B formed of non-expanding plastic foam is mounted on the first filling slab material 550A. Thereby, the seal portion 67 of the vacuum insulation member 60 is sandwiched between the first filling slab material 550A and the second filling slab material 550B.

Since the first filling slab material 550A and the second slab material 550B having a height t, which is approximately half the height T of the member 60, are superposed, the second filling slab material 550B and the vacuum insulation member 60 form a leveled surface (refer to c.)

(4) The slab material 530B formed of the non-expanding plastic foam adhered to the second panel 510B is placed above the second filling slab materials 550B and the vacuum insulation members 60, and pressurized adhesion is provided thereto (refer to d.)

The adhesive is either applied to the top surface of the vacuum insulation member 60 before pressurized adhesion, or the adhesive is applied to the whole surface of the slab material 530 of the second panel 510B contacting the vacuum insulation member 60, before being placed on top of the member 60 for pressurized adhesion.

The heat insulating wall 500 and the method of manufacturing

the same is advantageous in that the vacuum insulation members 60 may be securely mounted to a position away from the inner and outer plates 510A, 510B by a predetermined distance (base hole size for riveting + α) so that they receive small outer influence. Moreover, the vacuum insulation members 60 positioned approximately at the center of thickness of the wall would not be damaged of its insulating characters by vibration, torsion or outer force. Therefore, a secure insulation is provided.

Even further, since the heat insulating wall 500 is constituted of the vacuum insulation members 60 and the formed slab materials 530, 550 made of non-expanding plastic foam, the problems related to the spaces generated when cooling the expanding urethane foam injected in forms of material-liquid to the wall is solved. According to the present embodiment, the outer appearance would be improved, the members may be assembled without any gaps, and the heat insulating effect will be improved. Moreover, a plurality of heat insulating walls may be manufactured by a single pressurization step.

(Embodiment 5)

The present embodiment relates to a unit structure comprising the vacuum insulation member and the slab material, and the method of manufacturing the same (refer to FIGS. 8 and 9.)

A heat insulating wall 700 shown in the present embodiment comprises units, each formed by sandwiching the seal portion

67 of the vacuum insulation member 60 by slab materials formed of non-expanding plastic foam.

The method of manufacturing the heat insulating wall 700 is now explained.

(1) A first panel 510A acting as the outer panel, to which a first plate-shaped slab (insulating) material 530A made of a non-expanding plastic foam having a thickness of S (for example, approximately 25 mm) is adhered, and a second panel 510B acting as the inner panel, to which a second plate-shaped slab (insulating) material 530B made of a non-expanding plastic foam having a thickness of S (for example, approximately 25 mm) is adhered, are manufactured.

(2) A vacuum insulation member unit 700U is formed (refer to FIG. 9).

A cut slab material 770 is adhered and fixed to the vacuum insulation member 60.

The cut slab material 770 constitutes of a first cut slab material 770a and a second cut slab material 770b for sandwiching the seal portion 67 of the vacuum insulation member 60.

The first and second cut slab materials 770a and 770b are formed of a non-expanding plastic foam such as a styrene foam or an urethane foam. The cut slab materials are pillar-shaped, with a height t being half the height T of the vacuum insulation member 60 ($t = T/2$), and a width W equal to or a little longer than the width w of the seal portion 67 ($W \geqq w$).

The seal portion 67 of the vacuum insulation member 60 is

sandwiched between the first and second cut slabs 770a, 770b, which are adhered and fixed to position, thereby forming the vacuum insulation member unit 700U (refer to FIG. 9 a, b.)

(3) The vacuum insulation member units 700U are arranged on the first plate-shaped slab material 530A of the first panel 510A, and adhered to position (refer to FIG. 9 c.)

(4) The second slab material adhered to the second panel 510B is mounted and adhered, through an adhesive, on top of the vacuum insulation member units 700U.

The adhesive shown in this embodiment is similar to that explained in embodiment 1.

The vacuum insulation member 60 being reinforced (on both sides) by the first and second cub slab materials 770a and 770b is formed as a unit. The units are sandwiched between the first slab material 530A having a predetermined thickness and adhered to the first panel 510A, and the second slab material 530B having a predetermined thickness and adhered to the second panel 510B, so as to form the heat insulating wall 700.

Another embodiment of forming units comprising the vacuum insulation member 60 and the slab materials are shown in FIGS. 10 and 11.

A heat insulating wall 800 includes cut slab materials 870a, 870b which are each equipped with a hole 870 for inserting the seal portion 67 of the vacuum insulation member 60.

The cut slab materials 870a, 870b are formed of a non-expanding plastic foam such as a styrene foam or an urethane

foam. The height T of the pillar-shaped slab materials 870a, 870b are set to be the same height T as the vacuum insulation member 60, and the width size W of the slab materials are equal to or a little longer than the length w of the seal portion 65 of the member 60 ($W \geqq w$). A hole 870 is formed to one side of the cut slab materials 870a and 870b. The hole 870 is a concave portion formed to approximately the center of height T, and with a length (depth) equal to the length w of the seal portion 65.

The cut slab materials 870a and 870b formed as above are positioned to both sides of the vacuum insulation member 60. At this time, the seal portions 65, 65 of the vacuum insulation member 60 is each inserted to the hole 870 formed to the cut slab material 870a and the hole 870 formed to the cut slab material 870b. The members are adhered and fixed to position.

The unit 800U shown in the present embodiment is formed so that the cut slab material 870a is placed on one side of the vacuum insulation member 60, and the material 870b is placed on the other side of the member 60.

According to the heat insulating walls 700 and 800, and to the method of manufacturing the same shown in the above-mentioned embodiment is advantageous in that the most difficult and complicated steps of fixing the seal portion 65 of the vacuum insulation member 60 with the plastic slab materials in manufacturing a wall are simplified by forming units including the member 600. According to the present embodiment, the number

of steps performed before the pressurization step is reduced, and the productivity as a whole is improved. Moreover, the vacuum insulation members may be securely mounted to a position away from the inner and outer plates 510A, 510B by a predetermined distance S (base hole size for riveting + α) so that they receive small outer influence. Moreover, the vacuum insulation members 60 positioned approximately at the center of thickness of the wall would not be damaged of its insulating characters by vibration, torsion or outer force. Therefore, a secure insulation is provided.

(Embodiment 6)

The present embodiment relates to vacuum insulation members being sandwiched between molded beaded-expansion styrene foam bodies, which are heat insulating materials (refer to FIGS. 12, 13.)

A heat insulating wall 900 is formed by covering the vacuum insulation member 60 with a first storage body 950A and a second storage body 950B.

The first storage body 950A and the second storage body 950B are each equipped with a fitting portion 970 for fitting and storing the vacuum insulation member 60. The storage bodies 950A, B have a height H, and the fitting portion 970 has a depth t, which is close to half the height T of the vacuum insulation member 60 ($t \risingdotseq T/2$). The size S is a predetermined size, which is set to be equal to the base hole size for riveting plus some clearance. In other words, the height H of the storage body

950A is set to a predetermined size S plus half the height T of the vacuum insulation member 60 (H = S + T/2). Moreover, when denoting the width size of the vacuum insulation member 60 including the seal portions 67 as y, the width Y is equal to or a little longer than y, or Y $\geqq$ y.

The first and second storage bodies 950A and 950B are molded and formed from a beaded-expansion styrene by use of a metallic mold.

The method of manufacturing the heat insulating wall 900 is now explained with reference to FIG. 13.

(1) The vacuum insulation member 60 is fit to the fitting portion 970 of the first storage body 950A, and adhered to position. The seal portions 67, 67 are mounted on the upper area of the storage body 950A (refer to a, b.)

(2) The second storage body 950B is mounted to the upper portion of the first storage body 950A, and adhered thereto. At this time, the exposed portion of the vacuum insulation member 60 is fit to the fitting portion 970 of the second storage body 950B. Thereby, the unit 900U is completed.

(3) Units 900U are arranged and fixed on the first panel 510A. The second panel 510B is placed above the units 900U, in order to complete the wall 900.

The adhesive used in the present embodiment is similar to that explained in embodiment 1.

The heat insulating wall 900 includes units 900U formed by storing the vacuum insulation member 60 to the fitting portions

970, 970 formed to the first and second storage bodies 950A, 950B. The units are assembled by simple steps. Moreover, there is no need for slab materials utilized for positioning the vacuum insulation member 60, which enables to reduce the number of components needed for manufacturing the wall 900, and to improve the productivity. Even further, the vacuum insulation members may be securely mounted to a position away from the inner and outer plates 510A, 510B by a predetermined distance S (base hole size for riveting + α) so that they receive small outer influence. Moreover, the vacuum insulation members 60 positioned approximately at the center of thickness of the wall would not be damaged of its insulating characters by vibration, torsion or outer force. Therefore, a secure insulation is provided.

As explained, the heat insulating wall according to the present invention has the following advantages.

1. When the present wall is used as the wall for a heat insulating container of a vehicle, even when a great load is applied to the wall including serious deformation of the container caused by the vehicle driving on a rough path or riding over a curbstone and the like, the stress will not be conducted to the vacuum insulation member. The film will not be damaged by the deformation.

2. When the heat insulating wall is damaged from the inside or the outside of the container (for example, by claws of a fork lift, obstacles bumping on to the wall of the container,

and the like,) the vacuum insulation members in the wall will not be damaged.

3. When there is a need to fix parts to the inner and outer surfaces of the container (lashing rail, air rib, pallet guide, etc.), or mount rails and angle rivets (common pull-stem type) thereto, the forming of base holes (having a depth of approximately 15 mm) by a drill and inserting rivets to the holes will not damage the film of the vacuum insulation members in the wall. Therefore, the heat insulating characters of the wall will not be damaged.

Moreover, according to the present method of manufacturing the heat insulating wall, the vacuum insulation members could be positioned securely to the predetermined position within the inner and outer panels.